Geophysical Research Abstracts,
Vol. 11, EGU2009-3473, 2009
EGU General Assembly 2009

Suspended sediment fluxes in the Castle Creek glacier pro-glacial zone, Cariboo Mountains, British Columbia

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Global climate change is impacting watershed hydrology and our use of water-related resources particularly in snow and glacier-fed drainage basins. The dominant trend is that most glaciers are out of equilibrium with the current climate and they are slowly adjusting to seasonal changes in precipitation and higher temperatures by showing negative mass balance, significant volume loss and retreat in most areas. In terms of landscape evolution, this widespread and rapid retreat of mountain glaciers is revealing new expanses of fresh glacial debris, the stability, dynamics and potential fluvial transport of which is little understood.

This study was based in the pro-glacial zone of the Castle Creek glacier in the Cariboo Mountains of northern British Columbia, a glacier which has receded some 1.2 km in the past 50 years. Suspended sediment fluxes at three stations across the pro-glacial zone were monitored for 34-days in July-August 2008 in order to identify dominant sediment source areas, sediment fluxes between the stations and to determine the connectivity between glacial sediment production and downstream sediment fluxes. ISCO automatic pumping samplers, a pressure transducer and turbidity sensors were deployed and 459 water samples were retrieved from three stations and analysed gravimetrically for their suspended sediment concentration (SSC). A stage-discharge (Q) rating relationship was established at the distal end of the pro-glacial zone and an hourly Q record was maintained from 9 July – 12 August 2008.

The SSC v Q rating relationship changes with increasing distance from the glacier snout. The degree of scatter increases with distance across the pro-glacial zone indicating that the importance of Q in controlling SSCs diminishes towards the distal station, which is 1.2 km from the glacier snout. Suspended sediment loads were estimated by two methods: 1-hr and 3-hr SSC and Q data and sediment flux estimates by both methods were in good agreement. For the whole of the 34-day study period sediment flux at the Proximal station was estimated to be 1521 $\pm$ 24 t, 1976 $\pm$ 31 t at the Middle station and 2706 $\pm$ 38 t at the Distal station. With both methods in agreement, and relatively small standard errors, we can be confident that this pattern is real. SSC v turbidity (Tu) rating relationships are slightly stronger than those between SSC and Q which is promising for the future use of Tu sensors as a surrogate for SSC in this environment. Synchronous SSC traces for the Middle and Distal stations reveal some interesting observations which suggest that the system here is transport limited for the duration of the study and that there is no evidence to suggest a sediment supply limitation.

Castle Creek glacier pro-glacial zone is capable of increasing suspended sediment yields from $\tilde{5}$34 t km-2 yr-1 near the glacier snout to around 773 t km-2 yr-1 just over a km downstream. In other words, the pro-glacial zone has increased the suspended sediment yield by a factor of around 1.5. These figures highlight the rapid change in suspended sediment yield with distance from the glacier snout, and emphasise the potential impact of receding glaciers on sediment yields in mountain areas.

KEYWORDS: suspended sediment; pro-glacial; British Columbia; turbidity